THE CLAIMS

What is claimed is:

1. A storage and dispensing system for storing and dispensing a target gas, comprising:

   (a) a housing;

   (b) a plurality of microtubular elements disposed in said housing, wherein each of said microtubular elements comprises a tubular wall defining a bore side and a shell side, and wherein the bore side of each of said microtubular elements is sealed from the shell side thereof; and

   (c) a carrier material for said target gas, wherein said carrier material is disposed in said housing and at either the bore sides or the shell sides of said microtubular elements.

2. The storage and dispensing system of claim 1, wherein the carrier material for said target gas is disposed at the bore sides of said microtubular elements.

3. The storage and dispensing system of claim 2, wherein the carrier material for said target gas comprises at least one sorbent material having sorptive affinity for the target gas.

4. The storage and dispensing system of claim 3, wherein said sorbent material comprises a physical sorbent and/or a chemisorbent.

5. The storage and dispensing system of claim 3, wherein the target gas comprises hydrogen, and wherein the sorbent material comprises at least one hydrogen-sorbent.

6. The storage and dispensing system of claim 5, wherein said at least one hydrogen-sorbent comprises a material selected from the group consisting of metal hydride alloys, carbonaceous materials, zeolites, silica gels, amorphous metal compositions, and molecular sieves.

7. The storage and dispensing system of claim 2, wherein the tubular walls of said microtubular elements are not permeable to the target gas.

8. The storage and dispensing system of claim 2, wherein the carrier material for said target gas comprises a liquid carrier material.

9. The storage and dispensing system of claim 8, wherein the target gas comprises hydrogen, and wherein the liquid carrier material comprises at least one material selected from the group consisting of liquefied hydrogen, organic hydrogen solvents, and metal hydride solutions.

10. The storage and dispensing system of claim 1, wherein the carrier material for said target gas is disposed at the shell sides of said microtubular elements.

11. The storage and dispensing system of claim 11, wherein the carrier material comprises at least one sorbent material having sorptive affinity for the target gas.

12. The storage and dispensing system of claim 11, wherein said at least one sorbent material comprises a physical sorbent and/or a chemisorbent.

13. The storage and dispensing system of claim 11, wherein the target gas comprises hydrogen, and wherein the sorbent material comprises at least one hydrogen-sorbent.

14. The storage and dispensing system of claim 13, wherein said at least one hydrogen-sorbent comprises a material selected from the group consisting of metal hydride alloys, carbonaceous materials, zeolites, silica gels, amorphous metal compositions, and molecular sieves.

15. The storage and dispensing system of claim 10, wherein the tubular walls of said microtubular elements are permeable to the target gas.

16. The storage and dispensing system of claim 10, wherein the carrier material for said target gas comprises a liquid carrier material.

17. The storage and dispensing system of claim 16, wherein the target gas comprises hydrogen, and wherein the liquid carrier material comprises at least one material selected from the group consisting of liquefied hydrogen, organic hydrogen solvents, and metal hydride solutions.

18. The storage and dispensing system of claim 17, wherein the microtubular elements are potted at one or more ends by one or more potting members, so that the bore sides of said microtubular elements are sealed from the shell sides thereof by said one or more potting members in a leak-tight manner, wherein said one or more potting members and said housing define: (1) at least one liquid compartment for holding said liquid carrier material, and (2) at least one hydrogen collection compartment separated from said liquid compartment in a leak-tight manner, wherein said microtubular elements extend from said liquid compartment to said hydrogen collection compartment, so that the shell sides of said microtubular elements at least partially contact the liquid carrier material in the liquid compartment, and that the bore sides of said microtubular elements are in fluid communication with said hydrogen collection

compartment, and wherein the housing comprises at least one hydrogen outlet connected to said hydrogen collection compartment for dispensing hydrogen gas therefrom.

19. The storage and dispensing system of claim 18, wherein the tubular walls of the microtubular elements comprise a membrane material that is gas-permeable but liquid-impermeable.

20. The storage and dispensing system of claim 19, wherein said membrane material comprises a microporous, hydrophobic polymeric material.

21. The storage and dispensing system of claim 18, wherein the tubular walls of the microtubular elements comprises a first layer of structural material that is gas- and liquid-permeable, and a second layer of membrane material that is gas-permeable but liquid-impermeable.

22. The storage and dispensing system of claim 18, wherein the liquid carrier material comprises at least one metal hydride solution.

23. The storage and dispensing system of claim 22, wherein the metal hydride solution comprises $NaBH_4$.

24. The storage and dispensing system of claim 23, wherein the metal hydride solution comprises $NaBH_4$ at a concentration in a range of from about 10% to about 35% by total weight of said solution, and wherein the metal hydride solution further comprises sodium hydroxide at a concentration in a range of from about 2% to about 4% by total weight of said solution.

25. The storage and dispensing system of claim 22, further comprising a catalyst-based hydrogen release control mechanism associated with the liquid compartment.

26. The storage and dispensing system of claim 22, further comprising a pH-based hydrogen release control mechanism associated with the liquid compartment.

27. The storage and dispensing system of claim 22, further comprising a water supply for controllably adding water to the liquid compartment.

28. The storage and dispensing system of claim 27, arranged and configured for supplying hydrogen gas to a downstream hydrogen fuel cell assembly for generation of electrical energy, wherein said hydrogen fuel cell assembly comprises a water management mechanism for removing water generated during the electrochemical reaction from said assembly, and wherein the water supply of said storage and dispensing system is connected to the water management mechanism of the hydrogen fuel cell assembly, so that the water generated by said hydrogen fuel cell assembly is controllably added to the liquid compartment of the storage and dispensing system.

29. The storage and dispensing system of claim 22, wherein each of the tubular walls of said microtubular elements comprises a first layer of a catalyst material, a second layer of a membrane material that is gas-permeable but liquid-impermeable, and a third layer of a structural material that is gas- and liquid-permeable.

30. The storage and dispensing system of claim 22, wherein the tubular wall of each microtubular element is impregnated with a catalyst material and has a coating of a membrane material that is gas-permeable but liquid-impermeable on an inner surface thereof.

31. A hydrogen generation catalyst structure, comprising an immobilized hydrogen generation catalyst material and a plurality of microtubular elements in contact therewith, wherein each of said microtubular elements comprises a tubular wall defining a bore side and a shell side, and wherein the bore side of each of said microtubular elements is sealed from the shell side thereof.

32. The hydrogen generation catalyst structure of claim 31, wherein the hydrogen generation catalyst material is impregnated in the tubular walls of the microtubular elements.

33. The hydrogen generation catalyst structure of claim 31, wherein the hydrogen generation catalyst material is disposed at the bore sides of the microtubular elements.

34. The hydrogen generation catalyst structure of claim 31, further comprising a housing, in which the plurality of microtubular elements and the hydrogen generation catalyst material are disposed, wherein the hydrogen generation catalyst material is either impregnated in the tubular walls of the microtubular elements or disposed at the bore sides thereof, wherein the microtubular elements are potted at one or more ends by one or more potting members, so that the bore sides of said microtubular elements are sealed from the shell sides thereof by said one or more potting members in a leak-tight manner, wherein said one or more potting members and said housing define a first liquid compartment and a second liquid compartment separated from each other in a leak-tight manner, wherein said microtubular elements extend from said

first liquid compartment to said second liquid compartment, so that the bore sides of said microtubular elements are in fluid communication with the first liquid compartment, and the shell sides of said microtubular elements are in fluid communication with the second liquid compartment, wherein fluid flows between the first and the second liquid compartments by diffusing through the tubular walls of the microtubular elements, wherein one of the first and the second liquid compartments is connected to a fluid inlet, and the other is connected to a fluid outlet.

35. The hydrogen generation catalyst structure of claim 34, wherein the first liquid compartment is connected to a fluid inlet for introducing a metal hydride solution thereinto, wherein the second liquid compartment is connected to a fluid outlet, so that the metal hydride solution flows from the first liquid compartment into the bore sides of the microtubular elements, through the tubular walls thereof, to the shell sides of said microtubular elements, and being collected in said second liquid compartment, during which the metal hydride solution comes into contact with the immobilized hydrogen generation catalyst material in said microtubular elements for generation of hydrogen gas, and is then discharged from the fluid outlet.

36. A microfibrous fuel cell structure, comprising:

a hollow fibrous membrane separator defining a shell side and a bore side;

an inner current collector at the bore side of said hollow fibrous membrane separator;

an inner electrocatalyst layer at the bore side of said hollow fibrous membrane separator;

an outer current collector at the shell side of said hollow fibrous membrane separator;

an outer electrocatalyst layer at the shell side of said hollow fibrous membrane separator; and

a hydrogen supply structure at the bore side of said hollow fibrous membrane separator, which comprises a carrier material for hydrogen gas.

37. The microfibrous fuel cell structure of claim 36, wherein the carrier material comprises at least one hydrogen-sorbent.

38. The microfibrous fuel cell structure of claim 37, wherein said at least one hydrogen-sorbent is selected from the group consisting of metal hydride alloys, carbonaceous materials, zeolites, silica gels, amorphous metal compositions, and molecular sieves.

39. The microfibrous fuel cell structure of claim 36, wherein said hydrogen supply structure further comprises a fluid path within said carrier material, to allow passage of hydrogen gas therethrough.

40. The microfibrous fuel cell structure of claim 36, wherein said hydrogen supply structure further comprises a tubular membrane that encloses said carrier material, and wherein said tubular membrane is hydrogen-permeable.

41. The microfibrous fuel cell structure of claim 40, wherein the tubular membrane of said hydrogen supply structure comprises a porous polymeric membrane material.

42. The microfibrous fuel cell structure of claim 41, wherein said porous polymeric membrane material comprises a polymeric material selected from the group consisting of polyolefins, polysulfones, polyvinyl chloride, polyvinyl fluoride, polytetrafluoroethylenepoly-propylene copolymer, polyamides, polyphenylene oxidi-polystyrenes and polycarbonates.

43. The microfibrous fuel cell structure of claim 41, wherein said porous polymeric membrane material comprises polypropylene.

44. The microfibrous fuel cell structure of claim 36, wherein the carrier material comprises a liquid carrier material for hydrogen gas, and wherein said hydrogen supply structure further comprises a tubular membrane that encloses said liquid carrier material, and wherein said tubular membrane is hydrogen-permeable but liquid-impermeable.

45. The microfibrous fuel cell structure of claim 44, wherein said liquid carrier material comprises at least one material selected from the group consisting of liquefied hydrogen, organic hydrogen solvents, and metal hydride solutions.

46. The microfibrous fuel cell structure of claim 44, wherein said liquid carrier material comprises a metal hydride solution, and wherein the tubular membrane of said hydrogen supply structure comprises an outer layer of a microporous, hydrophobic polymeric membrane material, and an inner layer of a hydrogen generation catalyst material in contact with the metal hydride solution.

47. A fuel cell assembly comprising multiple microfibrous fuel cell structures as in claim 36.

48. A microfibrous fuel cell structure, comprising:

a hollow fibrous membrane separator defining a shell side and a bore side;

an inner current collector at the bore side of said hollow fibrous membrane separator;

an inner electrocatalyst layer at the bore side of said hollow fibrous membrane separator;

an outer current collector at the shell side of said hollow fibrous membrane separator;

an outer electrocatalyst layer at the shell side of said hollow fibrous membrane separator; and a carrier hydrogen material disposed at the shell side of said hollow fibrous membrane separator.